followed will so limit the position or nature of the fault that its detection becomes easy. Prof. Miles Walker has had exceptional experience with machinery during the last thirty years and so lays the greatest stress on those faults which occur most often; in some cases the faults are due to abstruse causes which make great demands on the expert's knowledge of physical science.

The subjects are well divided, chapters being devoted to break-down of insulation, over-heating, low efficiency, sparking at the brushes, etc. The method of determining the efficiency of an electric generator by air calorimetry—a method first devised and put into practice by Sir Richard Threlfall—is commended and the various methods of measuring the velocity of the stream of cooling air are described. The author attributes to Kennelly the discovery that the heat convection from a thin wire increases as the square root of the air velocity. It is true that Kennelly discovered this law experimentally, but the complete law had been deduced mathematically from physical principles several years previously by the French mathematician Boussinesq. He also proved theoretically Newton's law of cooling; namely, that the heat convected is proportional to the difference of temperature between the wire and the cooling fluid. This law, generally assumed as obvious by engineers, has been verified in the most satisfactory way by physicists.

In chapter 5 the practical application of vector diagrams is described, but the author does not distinguish clearly between the various kinds of vectors which are in everyday use. He begins by considering the vectors of two alternating functions which do not follow the harmonic law. The cosine of the angle between the two vectors is defined as the ratio of the mean value of their product to the product of the effective or root-mean-square value of each. It is therefore a highly complicated function. It can be shown that in accordance with this definition, when we have three alternating functions, their vectors can be represented by three lines drawn from a point in space. Hence, contrary to what the author says, a knowledge of the angles between the first and third and the second and third vectors does not enable us to give the angle between the first and second. The author then proceeds to describe rotating vectors, but he does not state explicitly that he is now making sine curve assumptions. The diagram representing as vectors the fluctuating part of the electrical power taken from the various mains requires more explanation.

The comments made on balanced loads are of interest, but are not very practical. It seems to the writer that a polyphase load is only balanced when the magnitudes of the volt-amperes taken from each main and the phase differences between the volts and amperes of each main are the same.

In a few cases where the author gives formulæ, as, for instance, the formulæ for eddy current losses, it would be a help to many if the proof were indicated. The limitations also of the formulæ should have been stated. A few new words are introduced. The phrase "wattful load" is used to indicate the power expended on the load. It is complementary to "wattless load," a phrase used almost universally by engineers to denote the magnetising power required by the load. Although many diagrams are given showing ripples in waves, harmonic analysis is barely mentioned. The causes of these ripples, however, are described, and many ingenious remedies are suggested.

The Inner Impulse.

La Forme et le Mouvement: essai de dynamique de la vie. By Georges Bohn. (*Bibliothèque de Culture générale.*) Pp. xii + 175. (Paris: Ernst Flammarion, 1921.) 4 fr. 50 net.

THE title leads one to expect a discussion of the effect of movement on the form of animals, perhaps new evidence for Lamarck. Nothing could be further from the author's intention. He seeks to show that the laws regulating the reproduction and growth of living creatures are the same as those which govern their movements, and that these are the laws of chemical physics. The conception of an organism as a whirlpool is at least as old as Cuvier, but remained little more than a useful analogy till F. Houssay superimposed on it the idea of vibration. But for him both the vortex and its vibrations expressed the effect on the creature of its environment. Prof. Bohn starts with molecules of living substance, the inherent vibrations of which produce a system not merely vortical but polarised, manifesting its internal forces through oscillations in space and in time. That sentence, so far as possible in Prof. Bohn's own words, will scarcely be intelligible to one who has not read the book. Nor, we are warned, will perusal of the book profit an inquirer unacquainted with the fundamental ideas of physics and mechanics. It may therefore be due to some gap in our knowledge that we rise from a second reading provoked but puzzled, interested but unconvinced.

It needs no very close acquaintance with modern biological research to realise the importance of chemical constitution. We have learned that every species has a chemical character of its own; we are familiar with the part that catalysers, hormones, and other more hypothetical substances, play or are supposed to play in all the functions of the body, in growth, and in the hereditary transmission of form. The study of

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tropisms and other movements of living beings has revealed how greatly these depend on purely physical forces. A mechanistic theory of life may not be correct, but is at least intelligible. Prof. Bohn, however, goes much further than this. He would explain the manifold variety of living form, past, present and future, by physico-chemical processes within the creature, influenced from outside only by corresponding chemical or physical factors acting directly. For selection or adaptation he has no use, holding a structure to be a consequence as inevitable as any precipitate in a laboratory test-tube.

Let us illustrate by two of Prof. Bohn's inferences. Stockard has shown that, in sea-water containing an excess of magnesium chloride, the eggs of the fish Fundulus develop cyclopic young to the extent of 50 per cent. These young are as vigorous as the controls, and swim with equal facility. "This fact shows that the evolution of the eye is effected not only, as the Lamarckians believe, under the influence of light, but that it may depend on a chemical factor." Similarly, the fact that various salts, or excess or deficiency of oxygen, favour or inhibit the growth of wings, leads Prof. Bohn to conclude that the insect fauna of oceanic islands must owe its wingless condition to some chemical agent. Wingless insects cannot well have migrated to, say, Kerguelen, but blind cave animals have, in Prof. Bohn's view, sought the seclusion which a cavern grants because they were already blinded.

Failure to follow such tenuous argument need not preclude a welcome to this little book for its insistence on facts and ideas that should certainly prove fruitful, if not on the precise lines imagined by its author. His conclusions seem to ignore that aspect of the unity of nature which is revealed in the myriad interrelations of living things, the delicate balance of life, and the intimate adjustment of successive generations to the changing surface of the Earth. If Prof. Bohn would lock his laboratory door and spend a year in the open field, he might there be exposed to some influences, which, though not purely chemical or physical, would change his mental attitude.

Economic Aspects of Human Wastage.

Waste in Industry. By the Committee on Elimination of Waste in Industry of the Federated American Engineering Societies. Pp. xii + 409. (New York and London: McGraw-Hill Book Co., Ltd., 1921.) 20*s.* net.

BRIEFLY to review this book is an almost impossible task, and the only way to accomplish it at all, while doing justice both to the writers and the public, is to give an indication of its contents and the methods employed, at the same time pointing out the fundamental importance of certain of the problems discussed.

The book is the report of a committee which made a detailed inquiry into certain industries with a view of finding out how waste of human effort occurred, and, so far as possible, to appraise the responsibility for such waste. The first part is a summary of the detailed reports, and may be taken as the general conclusions at which the committee arrived. The second part contains the detailed reports of the investigations into the building, clothing, boot and shoe, printing, metal, and textile trades. The third part contains general reports on such specific problems as unemployment, labour troubles, accidents, industrial hygiene, etc. This arrangement of the matter makes it extremely easy for the reader in search of special information to find what he needs with the least possible trouble. An attempt is made to determine the amount of waste due to inefficient management, want of planning, labour turnover, seasonal fluctuations, accidents, etc., and it is clear that a large proportion of the responsibility is due to management. This is necessarily the case, since any improvement reducing wastage from such causes as labour turnover and accidents must at least be initiated by those who are responsible for the general policy of industry.

A criticism that may be passed upon this work is that its outlook is narrow, for, with the exception of a few sections by medical men, attention is confined almost entirely to the economic aspect of human wastage. This is not really a serious criticism. A new science is growing up in all civilised countries which seeks to investigate the interaction between industrialism and human nature. To this infant science psychologists, physiologists, doctors, statisticians, and engineers are all contributing, and we must not blame any specific piece of work if one particular aspect of the question is somewhat over-emphasised. The very existence of such a science is a confession that these problems can no longer be regarded as the preserves of philanthropy or politics, which have both failed to remove any but the crudest abuses, while many of their endeavours to improve matters have done harm because they have been undertaken without knowledge of the scientific factors involved. For example, unemployment has too often been regarded merely as a problem of insurance, and various schemes have been worked out based upon the arguing power of the parties concerned rather than upon scientifically ascertained facts. Unemployment, as is pointed out in this book, has far wider ramifications, and cannot be treated from one point of view alone. However unemployment occurs, it involves a great national and

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